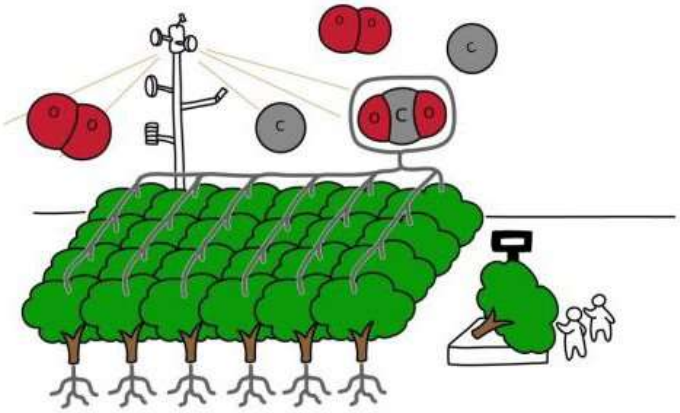

St1 - one of the leaders of sustainable biofuels

St1 is a Finnish energy company that pursues its vision of being a leading manufacturer and seller of CO2-efficient energy. The company is researching and developing commercially viable, environmentally friendly energy solutions. St1's energy services and products range from wind power to bio-waste based RE85 high alloy ethanol. The company operates advanced bioethanol production facilities in Finland and Sweden, has a refinery in Gothenburg, and has St1 and Shell stations in Finland, Sweden and Norway.

St1's goal is to build significant advanced ethanol production capacity in the Nordic and European markets. TuuliWat, a joint venture of St1's industrial wind power company, has 300 MW of electricity generation capacity under construction or is under construction and will reach 470 MW in 2017 with its ongoing projects.

Headquartered in Helsinki, St1 employs nearly 600 people in Finland, Sweden and Norway.

St1's value chain

Co-funded by the Erasmus+ Programme of the European Union

"St1 can't change the world through our solutions, but we can take small steps in the direction where we move ourselves from fossil world into a renewable world."

Mika Anttonen, Chairman of the Board

Making the ST1's vision to reality

The vision of St1 is to be the leading producer and seller of CO_2-aware energy. Renewable energy production is at the very core of the corporate strategy: our goal is to gradually repl ace fossil energy with renewable solutions.

The base of our business strategy lies in St1 Nordic Energy Outlook that summarizes the global energy challenge we all are facing. There is an urgent need in the world to create new, cost-efficient renewable energy solutions. Although the share of renewable energy is growing, fossil energy continues to grow much faster.

The transition to renewable energy is inevitable and it has already started. However, it requires a lot of R&D work and also smart political decisions to stop the climate change. St1 wants to be at the forefront of the energy industry in the transition process. We are constantly striving to identify opportunities and looking for competent cooperation partners in potential business segments and markets.

Focus on three most potential business areas

In St1, we are convinced that those renewable energy production forms that are cost-efficient and enable large-scale production, will be the successful ones in the future. We do our very best to understand the big picture and what the clients need in the future.

In order to bring more and more sustainably produced and affordable energy to homes, cars and businesses, we are focusing on the energy sources with the most potential to provide you with 1) advanced fuels from waste and residues, 2) renewable heat from the depths of the earth and 3) clean electricity from wind.

Strong performance in our traditional business segments - retail station operations and direct sales -enables investments in the future to realize the St1 corporate vision through renewable energy.

We believe that in ten year's time we will be able to produce renewable energy more cost-efficiently than fossil energy - thanks to our determined research and development of new solutions.

Advanced fuels from waste

Ethanol is globally the most widely used and well-known biofuel. It is liquid fuel that replaces gasoline directly in existing usage. There is no large investments needed for distribution networks.

The performance qualities of St1's waste-based advanced ethanol are superior compared to most other alternative biofuels and it generates up to 90% less CO2-emissions than conventional fossil fuels. It has the possibility to vastly reduce fossil fuel -based GHG-emissions in a fast way.

St1 is focusing on ethanol production technologies that utilize biowaste and residues. Our ongoing research and development projects increase the capacity of ethanol production as new feedstock and plant technologies become available. Suitable feedstock is found in every country in the world. The biggest potential in the future can be seen in the use of forest industry residues.

In addition to high quality fuel, depending on the feedstock, our biorefineries generate fodder, energy or heat as a side product.

Biowaste into bioethanol

Co-funded by the Erasmus+ Programme of the European Union

Aiming at the leading position on the Nordic wind power market

Wind power is one of the most cost-efficient forms of producing electricity. It utilizes a free and never-ending raw material: wind from the sun. Continuous development of wind power technology keeps improving the efficiency of power plants.

We utilize modern technology and decentralized energy production model to produce clean domestic electricity through TuuliWatti Oy – our associated company, co-owned with S-Voima. Over the past few years, TuuliWatti has systematically developed and built industrial wind power plants on land and has become the leading producer of wind power in Finland. Based on that know -how and experience we are expanding the operations to cover all the Nordic countries.

We are aiming at the leading position in all the markets we operate in. The focus of our investments is in the areas where it is most cost-efficient to produce electricity from wind – taking the location's wind circumstances and grid connections as well as social acceptance into consideration. We keep looking for projects, partnerships and investment opportunities in the Nordics. The Arctic areas are especially interesting in terms of renewable energy production potential.

Heat from the earth

Geothermal energy is a growing area in St1's renewable energy business. We are active in two kinds of operations that produce energy from geothermal heat: ground source heating and deep heat. In

the depths of the earth there lies enormous unused potential for sustainable energy and heat production - in fact, geothermal energy is one of the most cost-efficient ways to increase renewable energy in heating.

Deep Heat

INVESTMENTS IN THE FUTURE

Exploring new renewable energy technologies

The future energy team of St1 focuses on the sustainable and feasible energy solutions of the future. We are looking at the entire field of renewable energy and searching for potential new technologies that can be commercialized.

We are exploring the opportunities of, for example, energy storage systems and solar power in order to bring you new, smart energy options for the future.

The global energy challenge requires also a major increase in biological carbon sinks. St1 is planning to start a Carbon Farming demo project in Morocco in 2018 in order to explore reduction of coal from atmosphere with afforestation.

New raw materials and enzyme development

Searching for potential waste-based feedstock for biorefining

St1's research and development laboratory is testing and screening new potential raw materials to be used as feedstock in biorefining. The research is focused on waste-based feedstock, the main feasibility criteria being the availability and cost-efficiency of the raw material and sustainability of the biorefining process. According to EU regulations, advanced bioethanol can be produced from a limited variety of feedstocks outside the food chain. Especially in the Nordic countries there are plenty of non-food materials available – such as sawdust and forest industry residues. St1 is also looking in Thailand, where there is a great potential in cassava starch production waste. Our pilot tests in the laboratory have discovered that waste from cassava starch production is one of the best feedstock sources for our *Etanolix*® technology.

St1 has an ongoing research program to develop its own enzyme for cellulosic ethanol production. Enzyme use cost is one of the major cost components in cellulosic ethanol production. Our aim is to set up our own enzyme production on-site for our next *Cellunolix*® biorefinery investment.

Production optimization

Optimizing the different production phases and deliverables

St1 scientists are working closely together with the process engineers and business developers to develop future biorefineries. New processes are first studied in the laboratory at very small scale until they are ready to be transferred to the process engineers for designing industrial scale plants.

St1's biorefineries also produce products other than advanced ethanol, which are important to the overall cost efficiency of the process. For example, one co-product of our St1 *Cellunolix*® process is lignin – a residue of the enzyme hydrolysis step, which can be used to produce biocrude and co-fed into the traditional oil refinery for renewable diesel production. Other valuable co-products are turpentine and furfural. As our production volumes increase, we are looking for higher added value use to the process co-products, e.g., in the steel, concrete, fertilizer or plastics industries.

Wind power

Tuuliwatti Oy

Tuuliwatti Oy, our partnership company specializing in wind power production, is planning to expand its operations to the Nord-Pool power market area operating in Finland, Sweden, Norway and Estonia. The goal is to make use of the competence achieved in wind power building and operations, to secure the company's profitable growth and competitiveness both short and long term, as well as to decentralize wind power production geographically in order to minimize wind risk and political risks. The aim is to define the business plans and models as well as business goals concerning the expansion during the year 2018.

Grenselandet AS

In 2017, our Norwegian subsidiary, St1 Norge AS, signed a contract with a consortium consisting of Vindkraft Nord AS and Ny Energi AS to establish a company aiming to develop two wind park projects in the Finnmark area in northern Norway. The joint venture, named Grenselandet AS, will manage a wind farm development project.

Co-funded by the Erasmus+ Programme of the European Union

At the first stage, Grenselandet will focus on the development work and the environmental impact assessment. Based on the outcome of this process, further steps will be determined. The wind farm development work consists of two planning areas with a total production capacity of 900 MW.

Carbon farming pilot

Over hundreds of years, humankind has created a carbon debt of over 100 billion tons and even if the whole world stopped emitting greenhouse gases right now, climate change would still continue. There is a well-functioning tool that is globally recognized and cost effective; it's about planting trees and forests, i.e. afforestation or reforestation. Carbon farming is a supplementary to sectoral decarbonization measures, and paramount tool to fight climate change.

1. Planting forests is a globally recognized way, and the only feasible way, to reduce atmospheric carbon. Forests act as natural carbon sinks that capture CO2 from the atmosphere, and the results of Carbon farming are measurable and verifiable.

2. In desert or semi-desert areas, carbon farming can be achieved by producing a well-functioning irrigation system combined with suitable soil improvement. Sea water that has been desalinated using solar power or treated wastewater, can be used to irrigate a plantation. Additionally, there are large areas on the planet where carbon farming can be deployed without artificial irrigation.

3. Carbon farming benefits local populaces too. Large tree plantations can be combined with crop farming, leading to an increase in clean water, food production and monetary value. This could even ease the living conditions of populations who might otherwise be forced to migrate.

We have been preparing a Carbon farming pilot in Morocco to start in 2018. The negotiations with potential partners are ongoing. The aim of the pilot project is to test fast growing tree species at three different locations in Morocco.

Irrigation, soil improvement and fertilizer are included in the test and the target is to find the most suitable combination of all of the above mentioned.

Besides the pilot project, the carbon capture measurement and verifying methods are studied. The amount of carbon sequestered in the concept should be measured according the IPCC Guidelines to give precise and reliable data. The entire process needs to be regularly verified and audited to ensure legislative compliance. Verified and widely accepted measurement methods will be the prerequisite for economic basis and wider use of the Carbon farming concept.

St1 Nordic Energy Outlook

Population growth and GDP growth are the key drivers of increased energy demand, and the steep upward trend in all of them will continue for decades to come. The world does not have technological solutions needed to annihilate climate change. Major technological breakthroughs are needed in every segment, underlineing the need to step up R&D investments significantly from the current levels. At the same time it's paramount to find ways to change our behavior - in other words, to simply use less energy in our daily lives.

St1 Nordic Energy Outlook 2017 Edition presents our view of changes and challenges in the Nordic energy market during the next couple of decades. This is an update to the first Edition published in June 2016. As new elements we have included Aviation and Marine energy chapters, which lay out their development scenarios. The Electricity chapter now includes the outcome of St1's new

electricity market and price model. In the Road transport chapter we have further elaborated the ongoing EU regulative process and its potential impact on the Nordic countries. We have also updated the original pack where applicable.

As always, we are open to dialogue, and we love to be proved wrong in any of our analysis and claims. Thus, we invite you all to join the ride of continuous improvement of St1 Nordic Energy Outlook!

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